

## Work Authorization Document

### NSTX Upgrade Project

<b>Control Account #:</b>	2460	<b>Title:</b>	2nd NBI Armor
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<b>WBS</b>	1.2.4	<b>Title:</b>	NB Injection
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**Period of Performance:** 23 February 2009 through 03 April 2014

<b>Authorized Budget:</b>	\$700	<b>Control Account Manager:</b>	Tresemer
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<b>Revision #:</b>	0	<b>Revision Date:</b>	July-11
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**Authorized Work Description:**

This WBS element includes the design, fabrication, and installation of upgraded and relocated neutral beam armor including cooling and instrumentation work.

**Attachments:**

- 1- A detailed Control Account schedule showing all work packages and planning packages.
- 2- Budgeted Cost by month.
- 3- Original Work Authorization Form (WAF)
- 4- WBS Dictionary sheet that defines the scope of work for this WBS element.

#### Control Account History

ECP#	Implement Date	Prior Budget	New Budget	Signature

Approvals	Name	Signature	Date
NSTX-U Project Manager	R. Strykowski		
Control Account Manager	Tresemer		
Functional Manager	L. Dudek		

Activity ID	Activity Description	Work Days	BASELINE START	Forecast Start	BASELINE FINISH	Forecast Finish	Schedule Slip (Days)	Total Float	Budgeted Cost	PPCT	Earned value cost (BCWP)	Planned value cost (BCWS)	FY11	FY12	FY13	FY14	FY15	FY16
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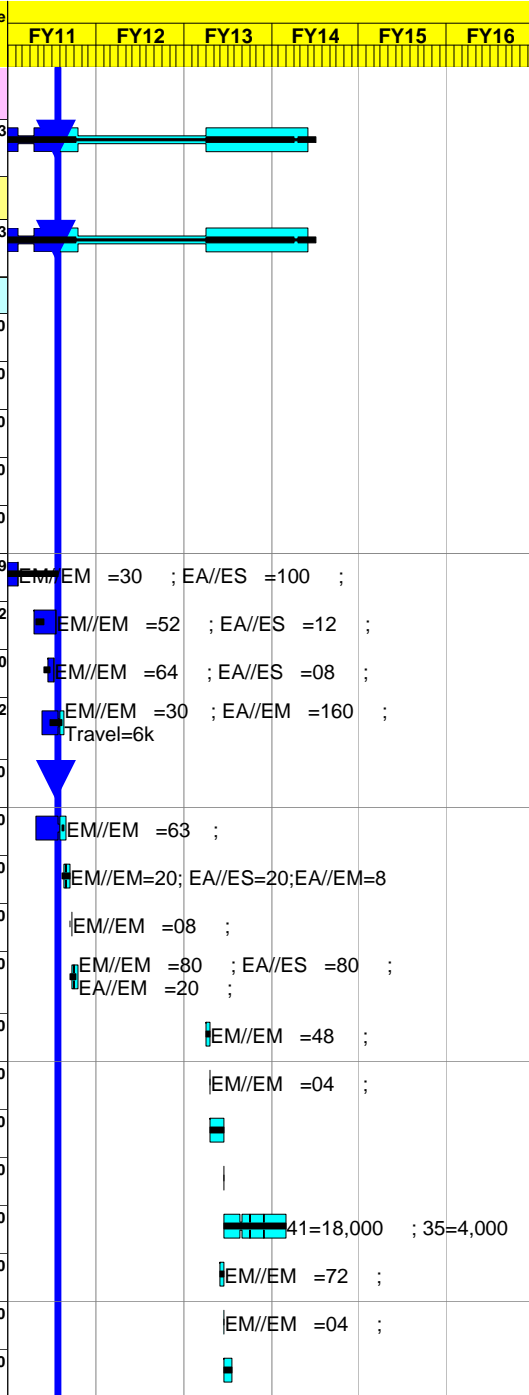
# NSTX Upgrade Project

Subtotal		1,256	23FEB09A	23FEB09A	03APR14	06MAR14	20	8	699,579.25		344,576.50	338,729.73						
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## Job: 2460 - 2nd NBI Armor-TRESEMER

Subtotal		1,256	23FEB09A	23FEB09A	03APR14	06MAR14	20	8	699,579.25		344,576.50	338,729.73						
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2460-0016	Armor Service Connection (Bay H)	10	06JUL10A	06JUL10A	19JUL10A	19JUL10A	0		0.00	100	0.00	0.00						
2460-0018	PDR Prep - NBI Armor	36	03MAY10A	03MAY10A	22JUN10A	22JUN10A	0		0.00	100	0.00	0.00						
2460-0019	CONDUCT PDR - NBI Armor	1	23JUN10A	23JUN10A	23JUN10A	23JUN10A	0		0.00	100	0.00	0.00						
2460-0020	Disposition PDR Chits - Final Design	23	28JUN10A	28JUN10A	29JUL10A	29JUL10A	0		0.00	100	0.00	0.00						
2460-0021	Revise Armor Backing &Armor service connecti	19	28JUN10A	28JUN10A	23JUL10A	23JUL10A	0		0.00	100	0.00	0.00						
2460-0022	Design Drawings	186*	02AUG10A	02AUG10A	29APR11	08NOV10A	116		12,719.68	100	13,129.69	13,129.69						
2460-0024	Armor Instrumentation/Service Connection	63*	27JAN11*	18JAN11A	24FEB11	14APR11A	-35		18,542.32	100	18,542.32	18,542.32						
2460-0025	Develop Installation Techniques	20*	25FEB11	15MAR11A	24MAR11	11APR11A	-12		10,821.60	100	10,821.60	10,821.60						
2460-0026	Update Analysis	63*	25MAR11	21FEB11A	13MAY11	18MAY11	-3	123	43,135.10	80	34,508.08	31,153.12						
2460-0026A	Peer Review - 2nd NBI Armor	0				14APR11A	0		0.00	100	0.00	0.00						
2460-0027	Update Cost & Sched Estimate - Final Dsgn	89*	16MAY11*	24JAN11A	23MAY11	26MAY11	-3	136	9,967.23	25	2,491.81	0.00						
2460-0028	FDR Prep - NBI Armor	21*	16MAY11	19MAY11*	13JUN11	17JUN11	-4	123	6,446.04		0.00	0.00						
2460-0029	Conduct FDR - NBI Armor	3	14JUN11	20JUN11	14JUN11*	22JUN11*	-6	123	1,265.68		0.00	0.00						
2460-0030	FDR Chit Resolution	20	15JUN11	23JUN11	13JUL11*	21JUL11*	-6	392	23,472.00		0.00	0.00						
2460-0031	Prep Requisition & Procuremnt Pckg - Armor Tiles	10	02JAN13*	02JAN13*	15JAN13	15JAN13	0	35	8,502.72		0.00	0.00						
2460-0032	Submit Request to Procurement - Armor Tiles	1	16JAN13	16JAN13	16JAN13	16JAN13	0	35	708.56		0.00	0.00						
2460-0033	Procurement Lead Times - Armor Tiles	40	17JAN13	17JAN13	13MAR13	13MAR13	0	35	0.00		0.00	0.00						
2460-0034	Award - Armor Tiles	1	14MAR13	14MAR13	14MAR13	14MAR13	0	35	0.00		0.00	0.00						
2460-0035	Fabricate / Delivery - Armor Tiles	180	15MAR13	15MAR13	27NOV13	27NOV13	0	35	29,234.00		0.00	0.00						
2460-0037	Prep Requisition & Procuremnt Pckg - Armor Tiles	10	01MAR13*	01MAR13*	14MAR13	14MAR13	0	153	12,754.08		0.00	0.00						
2460-0038	Submit Request t/Proc - Armor Support	1	15MAR13	15MAR13	15MAR13	15MAR13	0	153	708.56		0.00	0.00						
2460-0039	Procurement Lead Time - Armor Support	25	18MAR13	18MAR13	19APR13	19APR13	0	153	0.00		0.00	0.00						



Data Date: 30APR11 1105  
 Run Date: 20MAY11 10:55

NSTX UPGRADES  
 RESOURCE LOADED SCHEDULE  
 CD-2 Schedule  
 April 2011

Sheet 1 of 2

- █ Early Bar
- █ Progress Bar
- █ Critical Activity

Activity ID	Activity Description	Work Days	BASELINE START	Forecast Start	BASELINE FINISH	Forecast Finish	Schedule Slip (Days)	Total Float	Budgeted Cost	PPCT	Earned value cost (BCWP)	Planned value cost (BCWS)	FY11 FY12 FY13 FY14 FY15 FY16					
2460-0040	Award - Armor Support	1	22APR13	22APR13	22APR13	22APR13	0	153	0.00		0.00	0.00						
2460-0041	Fabricate / Delivery - Armor Support	60	01OCT13*	01OCT13*	06JAN14	06JAN14	0	42	60,750.00		0.00	0.00					41=45,000 ;	
2460-0043	Prep Requisition & Procuremnt Pckg-Backing Plate	2	03SEP13*	03SEP13*	04SEP13	04SEP13	0	21	2,479.96		0.00	0.00					EM//EM =14 ;	
2460-0044	Submit Request t/Proc - New Backing Plates	1	05SEP13	05SEP13	05SEP13	05SEP13	0	21	708.56		0.00	0.00					EM//EM =04 ;	
2460-0045	Procurement Lead Time - New Backing Plates	15	06SEP13	06SEP13	26SEP13	26SEP13	0	21	0.00		0.00	0.00						
2460-0046	Award - New Backing Plates	1	27SEP13	27SEP13	27SEP13	27SEP13	0	21	0.00		0.00	0.00						
2460-0047	Delivery - New Backing Plates	20	30SEP13	30SEP13	25OCT13	25OCT13	0	21	26,970.00		0.00	0.00					41=20,000 ;	
2460-0049	Fabricate Backing Plates	15	28OCT13*	28OCT13*	15NOV13	15NOV13	0	21	17,500.80		0.00	0.00					EM//EM =12 ; EM//SM	
2460-0050	Assemble Armor Quad #1	7	18NOV13	18NOV13	26NOV13	26NOV13	0	21	12,752.60		0.00	0.00					EM//SM =70 ;	
2460-0051	Assemble Armor Quad #2	5	27NOV13	27NOV13	05DEC13	05DEC13	0	21	9,109.00		0.00	0.00					EM//SM =50 ;	
2460-0052	Assemble Armor Quad #3	5	06DEC13	06DEC13	12DEC13	12DEC13	0	21	9,109.00		0.00	0.00					EM//SM =50 ;	
2460-0053	Assemble Armor Quad #4	5	13DEC13	13DEC13	19DEC13	19DEC13	0	21	9,109.00		0.00	0.00					EM//SM =50 ;	
2460-0054	Assembly Procedure Finalized	15	28JUN13*	28JUN13*	22JUL13	22JUL13	0	106	12,754.08		0.00	0.00					EM//EM =72 ;	
2460-0057	In Vessel Work Remove Armor	20	20JAN14*	11DEC13*	14FEB14	17JAN14	20	8	24,776.48		0.00	0.00					EM//SM =136 ;	
2460-0058	Armor Support Installation	10	17FEB14	20JAN14	28FEB14	31JAN14	20	8	25,127.20		0.00	0.00					EM//EM =08 ; EM//ST 41=8,000 ;	
2460-0059	Armor Quadrant Installations	15	03MAR14*	03FEB14*	21MAR14	21FEB14	20	8	29,759.28		0.00	0.00					EM//EM =12 ; EM//ST	
2460-0060	Service Connections	4	24MAR14	24FEB14	27MAR14	27FEB14	20	8	6,740.66		0.00	0.00					EM//SM =37 ;	
2460-0061	Bay-H Port Cover Install	3	28MAR14*	28FEB14*	01APR14	04MAR14	20	8	5,649.50		0.00	0.00					EM//EM =02 ; EM//SM	
2460-0062	PTP Testing - NBI Armor	2	02APR14*	05MAR14*	03APR14	06MAR14	20	8	2,922.56		0.00	0.00					EM//EM =08 ; EM//SM	
FY092460	FY09 Actual Cost	22*	23FEB09A	23FEB09A	30SEP09A	30SEP09A	0		35,786.00	100	35,786.00	35,786.00						
FY102460	FY10 Actual Cost	143	01OCT09A	01OCT09A	30APR10A	30APR10A	0		144,675.00	100	144,675.00	144,675.00						
FY102460A	FY10 Actual Cost	110	03MAY10A	03MAY10A	30SEP10A	30SEP10A	0		84,622.00	100	84,622.00	84,622.00	81=92189					







## Annex I – WBS Dictionary

This Work Breakdown Structure (WBS) organizes and defines the scope of the NSTX Upgrade using the WBS as established by the original NSTX project and modified to accommodate the NSTX Upgrade.

<u>WBS</u>			
<u>L1</u>	<u>L2</u>	<u>L3</u>	<u>Description</u>
1			<b>NSTX UPGRADE PROJECT</b>
	<b>1.1</b>		<b>Torus Systems</b>
		1.1.0	Project Integrated Model
		1.1.1	Plasma Facing Components
		1.1.2	Vacuum Vessel and Support Structure
		1.1.3	Magnet Systems
	<b>1.2</b>		<b>Plasma Heating and Current Drive Systems</b>
		1.2.1	High Harmonic Fast Wave (HHFW)
		1.2.2	Coaxial Helicity Injection (CHI) Current Drive
		1.2.3	Electron Cyclotron Heating (ECH)
		1.2.4	Neutral Beam Injection (NBI)
	<b>1.3</b>		<b>Auxiliary Systems</b>
		1.3.1	Vacuum Pumping System
		1.3.2	Coolant Systems
		1.3.3	Bakeout Heating System
		1.3.4	Gas Delivery System
		1.3.5	Glow Discharge Cleaning System
	<b>1.4</b>		<b>Plasma Diagnostics</b>
		1.4.1	Plasma Diagnostics
	<b>1.5</b>		<b>Power Systems</b>
		1.5.1	AC Power Systems
		1.5.2	AC/DC Converters
		1.5.3	DC Systems
		1.5.4	Control and Protection System
		1.5.5	General Power Systems and Integration
	<b>1.6</b>		<b>Central Instrumentation and Controls (I&amp;C)</b>
		1.6.1	Control System
		1.6.2	Data Acquisition System
	<b>1.7</b>		<b>Project Support &amp; Integration</b>
		1.7.1	Project Management and Integration
		1.7.2	Project Physics
		1.7.3	Integrated Systems Tests
	<b>1.8</b>		<b>Site Preparation and Assembly</b>
		1.8.1	Site Preparation
		1.8.2	Torus Assembly and Construction

## Annex I – WBS Dictionary

replacing copper impinged parts as required and refurbishment of the seals, thermocouple wiring, and bellows (cal and spool) as needed.

**{NSTX Beamline 2 Refurbishment (Job 2440)}**

Also included in this WBS element are the efforts necessary to relocate a TFTR neutral beam line and ancillary equipment into the NSTX test cell. This includes High Voltage Enclosures (HVEs) and the complete beam box.

**{NSTX Beamline 2 Relocation (Job 2425)}**

**WBS Element: 1.2.4.5**

**WBS Level: 4**

**WBS Title: NSTX Beamline 2 Services**

Definition: This WBS element includes the efforts to provide services to the new neutral beam beamline and ancillary equipment in NSTX test cell. These services include water, cryogenic systems, gas supplies, and vacuum lines.

**{NSTX Beamline 2 Services (Job 2450)}**

**WBS Element: 1.2.4.6**

**WBS Level: 4**

**WBS Title: NBI Armor**

Definition: This WBS element includes the design, fabrication, and installation of upgraded and relocated neutral beam armor including cooling and instrumentation work.

**{NBI Armor (Job 2460)}**

**WBS Element: 1.2.4.7**

**WBS Level: 4**

**WBS Title: NBI Beamline 2 Power and Controls**

Definition: This WBS element includes providing power, controls and instrumentation for the 2<sup>nd</sup> Neutral beamline.

Included in this WBS element is providing power for the NBI beamline 2. NB2 is planned to be powered from the TFTR NB4 A, B, & C line ups. The electrical equipment in these line ups will be reactivated. The TFTR NB4 HVEs will be relocated to the NSTX Test Cell as part of WBS element 1.2.4.4. New triax cables will be installed with terminations from the Modregs to the HVEs. New Decel coaxial cables will be installed from the Decel supplies to the Sources. The Arc, Filament, Magnet, and the 208 feeds, to HVEs cables, will be spliced in the TFTR Test Cell basement to new cabling designed and installed from the TFTR Basement to the NSTX Test Cell. The fiber cables also will be spliced with additional lengths recovered from other TFTR line ups. The AC auxiliaries and Grounding for the NB2 will be designed and installed.

**{NBI Power System (Job 2470)}**

Also included in this WBS element are the controls and instrumentation for the NB2. The work covers PLC, programming, control racks, new thermocouples, TC scanner, miscellaneous controls, and control cabling. The work also includes the gradient grid upgrade. System integration and testing will also be performed as part of this effort.



# Work Approval Form (WAF)

**Cost Center: 9418**

**Job Number: 2460**

**Job Title: NBI Armor**

**Job Manager: Craig Priniski**

**REV 1 6/10/2010**


**Description:**


This job includes design, fabrication, and installation of upgraded and relocated neutral beam armor including cooling and instrumentation work


**Schedule:**

Refer to Primavera Data-Base

**Approvals:**

 7-20-10  
\_\_\_\_\_  
Job Manager

 8/3/10  
\_\_\_\_\_  
Project Manager

 8/3/10  
\_\_\_\_\_  
Engineering Department Head



Cost Cent 18  
 Job Number.. 2460  
 Job Title: NBI Armor  
 Job Manager: Craig Priniski

task	SCHEDULE		Estimate (user input)										Basis of Estimate and Names of req'd skills if known	Category	% Uncertainty Positive	Negative			
	USER INPUT		HOURS																
	Duration in WORK DAYS	OPTIONAL Logical Pre-requisites (one task numbers in each column, any order)	USER INPUT Start Date (optional)	MAS (41)	CREDIT CARD (43)	OTHER (39)	TRAVEL (35)	OVERTIME (31)	EAM EM (analysis engr)	EAM DM (Designer)	EE SM/TB (Elect Tech)	EM EM (FO&M Engr)					EM SM/TB (FO&M Tech)	FCM (P&C Officer)	DP S/B/TB (HP Tech)
<b>Physics Requirements</b>																			
<b>Conceptual Design</b>																			
1	Armor Layout	PRINISKI	5		8/10/2009											4	20	COMPLETED	8
2	Thermal Analysis of Second Beam	TRESEMER	10		8/17/2009											40	64	COMPLETED	8
3	CD of Supports and plates	PRINISKI	15		8/17/2009											60	60	COMPLETED	8
4	Title modifications	TRESEMER	10		8/31/2009											80	40	COMPLETED	8
5	Bay H Port Cover Design	PRINISKI	10		9/15/2009											40	40	COMPLETED	8
7	CDR Prep	TRESEMER	8		9/29/2009											56	54	COMPLETED	8
6	PPPL CDR	PRINISKI	2		10/28/2009											16	16	COMPLETED	8
<b>Preliminary Design</b>																			
7	CDR Chit Resolution	TRESEMER	30		10/30/2009											0	48	COMPLETED	8
8	Design Components	PRINISKI	50		12/15/2009											0	40	COMPLETED	8
9	New Support Design	PRINISKI	51		12/15/2009											0	41	COMPLETED	8
10	Tile Thermal Modeling	TRESEMER	60		2/24/2010											0	48	COMPLETED	8
11	Tile Material Selection	PRINISKI	30		12/11/2009											73	10	COMPLETED	8
12	MSE-LIF Integration	BRYANT	13		4/12/2010											40	40	COMPLETED	8
13	Armor F-Mag Analysis	BRYANT	25		4/29/2010											0	16	COMPLETED	8
14	Armor Thermal Analysis	PRINISKI	10		6/3/2010											0	22	COMPLETED	8
15	Support Hardware Design	PRINISKI	4		4/14/2010											0	0	COMPLETED	8
16	Update Cost & Schedule Estimate	TRESEMER	5		6/17/2010											0	0	Prev. Reviews	8
17	PDR Prep	TRESEMER	2		6/24/2010											0	0	Prev. Reviews	8
18	CONDUCT PDR	PRINISKI	20		6/28/2010											0	16	Prev. Reviews	8
19	Disposition PDR Chits	PRINISKI	10		6/30/2010											0	24	Work to date	8
20	Armor Service connection (Bay H)	TRESEMER	20		7/26/2010											0	32	Prev. Reviews	2
21	Revise Armor Backing	TRESEMER	30		7/26/2010											0	101	Work to date	8
22	Design Drawings	TRESEMER	40		5/19/2010											0	48	Prev. Testing	4
23	Title Material Evaluation	TRESEMER	10		7/26/2010											0	12	Past Dealings	8
24	Armor Instrumentation (thermocouples)	PRINISKI	20		8/9/2010											0	64	Past Dealings	8
25	Develop Installation Techniques	BRYANT	36		9/6/2010											230	30	Work to date	8
26	Update Analysis	PRINISKI	4		10/16/2010											0	0	Prev. Updates	8
27	Update Cost & Schedule	TRESEMER	20		10/22/2010											0	0	Prev. Reviews	8
28	FDR Prep	TRESEMER	1		3/28/2011											20	80	Prev. Reviews	4
29	CONDUCT FDR	PRINISKI	20													0	0	Initial quotes	6
30	FDR Chit Resolution	TRESEMER	10													0	48	Prev. Experience	4
<b>Procurement</b>																			
<b>Item 1: Armor Tiles, CFCs</b>																			
31	Prep. Requisition and procurement packs	TRESEMER	10		3/29/2011											0	0		
32	SUBMIT REQ TO PROCUREMENT	TRESEMER	1		4/5/2011											0	0		
33	Procurement lead time (1)	TRESEMER	40		6/1/2011											0	0		
34	AWARD	TRESEMER	1		6/2/2011											0	0		
35	Fabricate for delivery	TRESEMER	260													0	0		
<b>Item 2: Bay-H Port Cover - Armor Supports</b>																			
36	Prep. Requisition and procurement packs	PRINISKI	10		4/5/2011											0	72	Prev. Cover purchase	6
37	SUBMIT REQ TO PROCUREMENT	PRINISKI	1		4/12/2011											0	4		
38	Procurement lead time (1)	PRINISKI	25		4/13/2011											0	0		
39	AWARD	PRINISKI	1		5/18/2011											0	0		
40	Fabricate for delivery	PRINISKI	60		5/19/2011											0	0		
41																0	0		







